In 1870 he succeeded in solving a question which was then attracting much attention—the question of the uniqueness of the representation of a function by Fourier's series. The extension of the result to cases in which the convergence of the series fails, at an infinite number of suitably distributed points, led him to construct a theory of irrational numbers, which has since become classical. From the same starting point he developed, in a series of masterly memoirs, an entirely new branch of mathematics—the theory of sets of points.

Having established the fundamental distinction between those aggregates which can be counted and those which cannot, Cantor showed that the aggregates of all rational numbers and of all algebraic numbers belong to the former class, and that the arithmetic continuum belongs to the latter class, and further, that the continuum of any number of dimensions can be represented point for point by the linear continuum. Proceeding with these researches he introduced and developed his theory of "transfinite" ordinal and cardinal numbers, thus creating an arithmetic of the infinite. His later abstract theory of the order-types of aggregates, in connection with which he has given a purely ordinal theory of the arithmetic continuum, has opened up a field of research of the greatest interest and importance.

Hughes Medal.

The Hughes Medal is awarded to Sir Joseph Wilson Swan, F.R.S., for his invention of the incandescent electric lamp, and his other inventions and improvements in the practical applications of electricity. Not as directly included in the award, his inventions in dry-plate photography, which have so much increased our powers of experimental investigation.

NOTES.

THE council of the Royal Society of Edinburgh at its recent meeting decided to award Sir James Dewar, F.R.S., the Gunning Victoria Jubilee prize for 1900–4 for his researches on the liquefaction of gases extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperatures.

THE *Times* reports that a telegram by wireless telegraphy has been transmitted by Mr. Marconi from the Marconi Company's station at Poldhu, Cornwall, to a station belonging to the Italian Government at Ancona, Italy. The distance between Poldhu and Ancona, about 1000 miles, is almost entirely overland, and in order to reach their destination the ether waves had to pass over nearly the whole of France and a considerable part of Italy, including some of the highest mountains of the Alps.

THE will of the late Dr. Frank McClean, F.R.S., includes the following bequests:—5000*l.* to the University of Cambridge to be expended in improving the instrumental equipment of the Newall Observatory, 5000*l.* to the University of Birmingham (in addition to his previous subscription) to be applied in the department of physical science, 2000*l.* to the Royal Society, 2000*l.* to the Royal Institution, 2000*l.* to the Royal Astronomical Society, and to the University of Cambridge for presentation to the Fitzwilliam Museum all the testator's illuminated or other manuscripts and early printed books, and all objects of mediæval or early art which the director of the museum may select as being of permanent interest to the museum.

IN a recent letter to the *Times* Prof. T. Clifford Allbutt directs attention to the paramount importance of considering the question of diet in all schemes of physical education. It is important that there should be no hasty legislation in this matter, especially in view of the important researches which are now approaching completion. Prof. Allbutt gives in his letter a brief account of the results at which Prof. Atwater, of Middletown, Connecticut, and Prof. Chittenden, of Yale University, have arrived. Prof. Atwater has measured accurately, upon healthy persons in uniform circumstances, the intake of food, and the output of waste and work, and has endeavoured to determine the modes and rates of conversion of foods into bodily and mental energy. Much of this expenditure of energy is upon an excess of food taken beyond the needs of the individual. Such excess (or not more than 4 per cent. of it) does not escape mechanically and cheaply from the body, but is absorbed, distributed, and excreted; to this process no little energy is diverted. In this useless effort energy is chiefly wasted by the nitrogenous foods. Excessive starches and sugars are burned off in the lungs almost directly, and at far less cost. Prof. Atwater teaches that the ordinary man eats too much, and in so doing wastes energy which he might have used to profit. Prof. Chittenden comes to a like conclusion by somewhat different methods. He will publish shortly tables to show how, on a closer adjustment of kinds and quantities of food to the useful work required, not only is this much work still sustained, but, by release of energy ordinarily dissipated in the demolition of food excess, the sum of work put out is prodigiously increased, in some cases even by so much as 60 per cent. or 70 per cent. It is clear enough already that one of the chief factors of physical well-being is to know what to eat, and what quantity of it results in the production of the maximum of useful energy. Until this is known with more exactitude than is common to-day, systems of physical education must be tentative and imperfectly conceived.

PROF. S. NEWCOMB has been elected corresponding member of the Berlin Academy of Sciences.

PROF. FEHR contributes to *l'Enseignement mathématique* for November 15 a list of the principal exhibits of models and books at the mathematical congress last August. Among the publishing firms exhibiting books, Germany was represented by six, Austria by two, France by four, Italy by five, Switzerland, Belgium and Denmark each by one. This is exclusive of books exhibited by societies and individuals, under which category we find the solitary British exhibit, by the Royal Irish Academy. Among the exhibitors of models our country was represented by Prof. Greenhill.

THE Belgian Government has decided upon the construction of a turbine steamer for its Channel fleet. Gradually the 19-knot steamers on this international service will be replaced by new turbine boats, with a speed of 23 knots, so that eventually even the slowest mail boats under the Belgian flag will have a speed of 21½ knots, or 24 miles an hour. The steamer which will inaugurate this departure in the progress of the service is at the present moment on the stocks at Hoboken, near Antwerp, and it will shortly be launched. Until quite recently, all steamships in the Channel and Irish Sea services were of the paddle-wheel type, a class admirably adapted for these comparatively short journeys. Drawing little water, they were able to enter any of the shallow harbours, and, at the same time, were capable of developing a speed altogether out of proportion to their draught. Since the introduction of turbines the diminution of the diameter of the propeller and of the weight of the engines has been rendered possible, so that what was until lately considered a mechanical impossibility, namely, to construct a steamer drawing only 9¾ feet and developing 12,000 indicated horse-power, may now be taken as a problem solved. The new Dover-Ostend mail boat will be a triple-screw steamer driven by Parsons' marine steam turbines. There will be three turbines—a high-pressure one in the centre, receiving the steam direct from the boilers, and a low-pressure one on each side, driven by the exhaust from the central engine. The Marconi system of wireless telegraphy will be installed, and remain at the service of the travelling public, as on all the Belgian mail steamers.

THE articles in the fourth part of vol. xxxii. of Gegenbaur's *Morphologisches Jahrbuch* are two in number, the one, by Dr. Böse, on variations in certain muscles of the human thorax, and the other, by Mr. A. Gierse, on the brain and cephalic nerves of the small deep-sea teleostean fish *Cyclothone acclidens.* The latter is remarkable for possessing a median cephalic sympathetic nerve-cord, apparently unknown in any other vertebrate.

ACCORDING to the report of the annual meeting held in May last, the Boston Society of Natural History (U.S.A.) is devoting attention to the display in its museum of the fauna of New England. New England palæontology is to be shown in the eastern end of the building between the rooms devoted to the palæontology of the rest of the world, while the remaining available space will be devoted to the recent birds and mammals. In the galleries will be arranged the lower vertebrates and the invertebrates. Accordingly, the local fauna, which is to be the leading feature of the museum, will occupy the most prominent and central position, from which the various portions of the general collection will diverge. This is as it should be, and when complete the museum promises to be a model for other local institutions of a similar nature.

THE first part of vol. lxxviii. of the *Zeitschrift für wissenschaftliche Zoologie* is devoted to the fourth and apparently concluding section of Dr. E. Rohde's valuable and exhaustive account of the structure of the organic cell, and to an article by Mr. D. Deineka on the constitution of the swim-bladder of fishes. In the second of these articles the author supports the view that the main function of the swim-bladder is hydrostatic; fish in which this organ has been pierced, and the whole or part of its contained gas withdrawn, or replaced by water, completely lose their balance, in some cases falling on one side, in others standing nearly perpendicular in the water with the head downwards, and in others, again, floating belly upwards. Whether, however, the swim-bladder has a double function, and acts also as a respiratory organ, is, in the author's opinion, extremely doubtful.

IN the September issue of the *Proceedings* of the Philadelphia Academy Miss A. M. Fielde records three instances of curious traits displayed by ants kept under observation in the laboratory at Woods Holl, Mass. In the first case the actions recorded suggest something akin to hypnotism, while from the third there seems a possibility that these insects may be able to remember and recognise individuals of their own kind after a separation of several years. The reactions of ants to vibrations form the subject of a second article by the same author in conjunction with Mr. G. H. Parker. In this it is urged that it is misleading to ascribe or to deny hearing to these insects. They are very sensitive to the vibrations of solids, but not to those of air, and their reactions to these might as well be described as due to touch as to hearing.

THE appearance of a bark disease among the Para rubber trees in certain districts in Ceylon during 1903 created some alarm among rubber planters, but prompt measures for its treatment were carried out under the advice of the Government mycologist. Mr. J. B. Carruthers, the officer in question, gives an account of its occurrence in his report, which forms No. 16 of vol. ii. of the *Circulars and Agricultural Journal* of the Royal Botanic Gardens, Ceylon, and states that the disease was due to a canker fungus; further details with regard to structure and treatment will form the subject of a separate circular.

THE *Journal of Botany* (November) contains the first part of a detailed description of the plants collected in Patagonia by Mr. Hesketh Prichard, of which a preliminary list was given in his book "Through the Heart of Patagonia." The identification has been undertaken by Dr. Rendle, who prefaces the list of plants with a short account of the region in which the collections were made, and the typical elements which are represented. The new species belong chiefly to characteristic temperate South American genera. To the same number Mr. A. B. Jackson contributes some notes on Leicestershire plants which summarise observations made since the year 1886, when the "Flora of Leicestershire" was published.

DR. W. E. DE KORTÉ, at a meeting of the Pathological Society of London on November 15, described what he believes to be the parasites of small-pox and vaccinia. In the lymph of the eruptive spots in both these diseases he has detected bodies measuring about 1/2500 inch in diameter, amœboid, and containing refractile granules; these he regards as amœboid protozoa. They are extremely delicate, breaking up and disappearing on all but the gentlest manipulation, and on attempts to stain or preserve. They seem to be very similar to the bodies described by Funck some years ago under the name of *Sporidium vaccinale*.

IN an article on trypanosome diseases (*Brit. Med. Journ.*, November 26) Prof. Robert Koch advances arguments in favour of the view that the trypanosomes of mammals at present known belong to about three species, viz. the rat trypanosome and the *T. Theileri* of South African cattle, both of which are distinguished morphologically and by unchanging virulence and inoculability from the other trypanosomes, *i.e.* those of nagana, surra, mal de caderas, and sleeping sickness, all of which show considerable variation in morphology, virulence, and inoculability, and are therefore regarded by Prof. Koch as being probably varieties of one type.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* contains papers on the north-western boundary region of Togoland, by Count Zech, and on the results of an exploration of the healthy plateau region of the Kamerun, north of the Manenguba mountains, by Dr. Hans Zieman. The information in the former paper, and the map accompanying it, are of particular interest on account of the immediate proximity of the district to British territory.

THE July number of the *Bulletin* of the Italian Geographical Society contains the concluding portion of Prof. Brocherel's report on the expedition to Central Asia in 1900. Signor Carlo Rossetti writes on the political and economic conditions of Korea, and Signor Eugenio Barbarich makes an important contribution to the physical geography and geology of Albania. Another paper deals with the award of the King of Italy in the arbitration as to the boundary between Brazil and British Guiana.

PROF. PENCK'S account of the progress made during the last five years in the execution of a map of the world on a scale of 1 : 1,000,000, which was presented to the International Geographical Congress at Washington, is published in the October number of the *National Geographic Magazine*. During the last four years France, Germany, and Britain have issued three series of maps, containing sixty-one sheets worked out on the same scale and in the same style of division of sheets. These maps cover nearly 10,000,000 square miles, and will ultimately embrace the whole of Africa, and large parts of Asia and America. It will be remembered that the congress adopted a resolution proposing to the Government of the United States the execution of a similar general map of America.

In a recent number of the *Bulletin* of the Italian Aëronautical Society Dr. L. Palazzo, director of the Italian Meteorological Service, gives a very interesting account of the scientific experiments in Italy with unmanned balloons. The paper contains photographic illustrations of the balloons employed, of the methods of filling them, of their flight in mid-air, and of the records of the instruments. The place chosen for the aëronautical station is Pavia, principally owing to its geographical suitability and its distance from mountains and sea. The balloons used are a preparation of india-rubber, and are made by the Caoutchouc Company, of Hanover. They are sent up in tandem fashion, and are spherical and closed, and have the faculty of expanding to about seventy times their original volume, rising rapidly to an altitude of 20,000 metres and upwards, where a temperature of 60° C. below zero may be recorded. The upper balloon eventually bursts; the second balloon, which is smaller and not fully inflated, does not burst, but acts as a kind of parachute, which commences to fall rapidly at first and afterwards more gradually. It carries the registering apparatus attached to it by a line, and is intended to attract the attention of persons in the neighbourhood of its descent. The instruments generally reach the ground somewhat gently, and are seldom broken. Dr. Palazzo acknowledges the assistance he has received from Profs. Hergesell and Assmann in inaugurating these important experiments.

We have received a reprint of a paper published by Prof. A. Righi in the *Atti dei Lincei,* vol. xiii., ii., 233, under the title of "Certain Phenomena Observed in Air which is Ionised by Radio-active Substances"; experiments are described which show the necessity that exists in making measurements of the ionising power of radio-active substances by means of the various forms of gold-leaf electroscopes to take into account the position of the leaves relatively to the walls of the electroscope, and to the direction of the ionising rays.

In a paper published in the *Physikalische Zeitschrift* (No. 20), C. Liebenow calculates that the presence of 1/5000 of a milligram of radium per cubic metre distributed uniformly throughout the earth's volume would be sufficient to compensate for the loss of heat which is caused by conduction through the crust, and thus to maintain the earth's interior at a constant temperature. The concentration which is here assumed is considerably less than that actually observed by Messrs. Elster and Geitel to hold for radium in various kinds of natural earths, but it may perhaps be assumed that the proportion of radium is greater in the crust of the earth than at the interior. In any case, the need becomes apparent of making allowance in all calculations dealing with the earth's rate of cooling, for the remarkable thermal effects of radio-active substances.

In No. 17 of the *Revue Scientifique,* Prof. R. W. Wood's recent letter to Nature (vol. lxx. p. 530) calling into question the existence of the *n*-rays is reprinted, and in No. 18 an editorial article discusses in detail the character of the evidence on which they are alleged to exist. In No. 19 of the *Revue* the opinions of Profs. Berthelot, Bouty, Pellat, Langevin, and Abraham have been ascertained with regard to the matter. Of these expressions of opinion, that of M. Langevin is the most emphatic; after making many experiments, he concludes that in no case in which the observer is unaware of the result he is to obtain is there the slightest evidence of the existence of these rays, whilst on the other hand the experimenter can readily so dispose his mind as to see whatever he wishes to see. The general attitude which is taken up in these articles is that the observed phenomena are purely subjective, and due to suggestion; they are consequently more likely to prove of importance to the psychologist than to the physicist.

In the October number of the *Gazzetta* G. Bruni and A. Callegari have established by means of cryoscopic measurements the remarkable fact that in many cases the nitroso-group in organic substances is isomorphous with the nitro-radical. The formation of solid solutions in such cases is also made evident by peculiar colour phenomena. Whilst, for instance, a solution of nitrosobenzene in benzene is green, but becomes colourless when frozen, a solution in nitrobenzene, which has the same colour, remains green after solidification. In the former case solid colourless nitrosobenzene has separated, whilst in the latter a solid solution of the substance in the solidified solvent is formed, which, like the liquid solution, is coloured green.

The numerous attempts which have been made to decide by physical methods the nature of isodynamic substances such as ethyl acetoacetate and acetylacetone have given rise to widely differing opinions. Thus Brühl, for instance, has considered that the optical properties of acetylacetone between 0° C. and 100° C. prove that, between these temperatures, it exists solely in the di-enolic form

$$CH_3.C(OH):C:C(OH).CH_3,$$

whilst Dr. W. H. Perkin, from a study of the magnetic rotatory power of the same substance, considers that at 16° C. it consists of a mixture of this form with the keto-enolic modification, and at 93° C. of a mixture of the keto-enolic and diketonic varieties. In the October number of the *Gazzetta* F. Giolitti shows that at about 70° C. a remarkable change in the expansibility of acetylacetone occurs which conforms with Perkin's view of a change of structure at a temperature between the limits 16° C. and 93° C. The variation in the expansion of ethyl acetoacetate between −10° C. and 100° C. is, however, perfectly linear, apparently indicating that at these temperatures only one form exists, or that the rate of change of one form into another is uniform between these limits.

A correspondent points out that in Nature of November 24 (p. 88, line 19 from top, first column) the name Sansaulito is a misspelling for a well known locality near San Francisco. The correct spelling is Saucelito, which means "little willow," from *Sauce,* willow, in Spanish.

We have received from Messrs. F. Darton and Co., of 142 St. John Street, E.C., a well illustrated catalogue of electrical novelties. The pieces of apparatus, toys, and household devices of which particulars are given are ingenious in design, and some of them would make instructive presents for boys with a mechanical turn of mind.

Messrs. Watts and Co. will issue on December 7 for the Rationalist Press Association an English translation of Prof. Haeckel's "Die Lebenswunder," under the title of "The Wonders of Life." The chief aim of Prof. Haeckel in this work is to present a mass of biological evidence for the views as to the origin and nature of life which he briefly advanced in the "Riddle of the Universe."

MESSRS. GEORGE BELL AND SONS have published a revised re-issue of "Cities and Sights of Spain," by Mrs. Aubrey Le Blond (Mrs. Main). This handbook for tourists is meant as a supplement to the ordinary guide-book, and the information supplied shows that the writer has an intimate first-hand knowledge of the country. The advice as to hotels, expenses, what to do and what not to do, is of just the kind to be of assistance to visitors to Spain, of which country the writer says, "no other part of Europe offers so varied and attractive a field to nearly every type of traveller." The appearance of this re-issue is particularly opportune just now, since astronomers and others will be visiting Spain next year to view the total eclipse of the sun, as the central line of the eclipse runs in a direction N.W. to S.E. across that country. Mrs. Le Blond's book may be commended to those scientific visitors who will have time to visit some of the beauty spots of the land in which their observations will be made.

WE have received vol. xxxvi. of the *Transactions and Proceedings* of the New Zealand Institute, which contains details of the work of the year 1903. The transactions are divided into five sections—miscellaneous, zoology, botany, geology, and chemistry and physics. The total number of papers contributed in these subjects reaches fifty. Among the contributions to the miscellaneous section may be mentioned several statistical studies by Prof. H. W. Segar and an exhaustive consideration of Maori marriage customs by Mr. Elsdon Best. The president of the institute, Captain F. W. Hutton, F.R.S., is the largest contributor to the section of zoology. He describes a new fish, two new flies, a new blow-fly from Campbell Island, and has papers on a new Weta from Chatham Islands and on the occurrence of the curlew sandpiper (*Ancylochilus sub-arquatus*) in New Zealand. Prof. Benham writes of a new species of leech (*Hirudo antipodum*) recently discovered in New Zealand, of the Oligochæta of the New Zealand lakes, and of an apparently new species of Regalecus (*R. parkeri*). Prof. Park contributes to the section of geology five papers on different aspects of New Zealand geology. Of the six papers in chemistry and physics, three are the work of Mr. J. S. S. Cooper. The proceedings, which make up the second part of the volume, provide interesting particulars of the year's work of each of the seven scientific societies affiliated to the New Zealand Institute. The volume as a whole demonstrates conclusively that the men of science in New Zealand are doing successfully their part to extend the bounds of natural knowledge.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER :—

Dec. 1. 10h. 9m. to 12h. 8m. Transit of Jupiter's Sat. III.
,, 10h. 22m. Minimum of Algol (β Persei).
,, 13h. 56m. to 14h. 8m. Moon occults η Virginis (Mag. 4·0).
4. 7h. 11m. Minimum of Algol (β Persei).
8. 13h. 43m. to 15h. 45m. Transit of Jupiter's Sat. III.
10–12. Epoch of Geminid meteoric shower (Radiant 108° + 33°).
11. 12h. 0m. Saturn in conjunction with Moon (Saturn 3° 28′ S.).
12. 1h. Juno in conjunction with Moon (Juno 0° 49′ S.).
13. 10h. 19m. to 11h. 12m. Moon occults λ Aquarii (Mag. 3·9).
,, 21h. 0m. Mercury at greatest elongation (20° 30′ E.).
16. 17h. Jupiter in conjunction with Moon (Jupiter 1° 47′ N.)
20. 6h. 1m. to 7h. 4m. Moon occults γ Tauri (Mag. 3.9).
,, 11h. 25m. to 11h. 58m. Moon occults θ′ Tauri (Mag. 3·9).
Dec. 20. 12h. 21m. to 13h. 31m. Moon occults BAC 1391 (Mag. 4·9).
,, 15h. 19m. to 16h. 12m. Moon occults α Tauri (Mag. 1·1)
21. 21h. 0m. Uranus in conjunction with Sun.
24. 8h. 54m. Minimum of Algol (β Persei).
26. 9h. 2m. to 9h. 13m. Moon occults A Leonis (Mag. 4·6).
27. 5h. 43m. Minimum of Algol (β Persei).
,, 21h. Venus in conjunction with Saturn (Venus 0° 48′ S.)
28. 10h. Neptune in opposition to the Sun.
29. 12h. 0m. Neptune's Satellite at max. elong. west (distance 17″).

ENCKE'S COMET (1904 *b*).—No. 3980 of the *Astronomische Nachrichten* contains the results of further observations of Encke's comet.

Prof. Millosevich, observing at the Roman College Observatory at 6h. 26m. 15s. (M.T. Rome) on November 7, determined the position of the comet to be

α (app.) = 22h. 50m. 39·93s., δ (app.) = +22° 19′ 20″·1,

and recorded the object as an extraordinarily difficult one with the filar micrometer of the 39 cm. equatorial; no nucleus could be definitely seen.

On November 15 Herr Moschick, using the 6-inch telescope of the Konigstuhl Observatory, Heidelberg, found the comet to be a very faint and diffuse object with a doubtful nucleus. The position at 13h. 12m. (Konigstuhl M.T.) was α (app.) = 22h. 13m. 37·6s., δ (app.) = +18° 14′ 26″.

The following is a corrected ephemeris, by M. Kaminsky, given in the November number of the *Observatory* :—

Ephemeris (Berlin Midnight).

1904	R.A.	Dec.
	h. m. s.	°
Nov. 29	21 18 30	+10 30
Dec. 3	21 3 50	+ 8 9
,, 7	20 49 20	+ 5 36
,, 11	20 34 10	+ 3 1
,, 15	20 16 32	+ 0 17
,, 19	19 56 38	− 2 58
,, 23	19 35 12	− 6 31

On the last mentioned date the comet will be a little north of κ Aquilæ, and owing to its proximity to the sun in right ascension will be a difficult object to observe.

As pointed out by Dr. Smart, the comet will approach very near to Mercury in January, and it is hoped that an opportunity of testing the mass of Mercury, by observations of the comet after the approach, will therefore be available.

VARIATIONS ON THE MOON'S SURFACE.—In No. 4, vol. liii., of the Harvard College Observatory *Annals* Prof. W. H. Pickering publishes a number of photographs illustrating the changes which take place in the regions about the lunar crater Eratosthenes during the commencement, the duration, and the passing of sunlight on that region of the moon's surface.

There are sixteen figures in all, the longest interval of time between the taking of any two successive figures being 1·6 days, and it is hoped that, by publishing these together with the detailed descriptions by Prof. Pickering which accompany them, the work of other selenographists may be greatly facilitated, by the possession of the knowledge of what to look for.

The mean diameter of the crater of Eratosthenes is 37 miles, that of the floor 28 miles, and measures of the shadows cast indicate that the western wall has a height of 12,000 feet, whilst the indicated height of the eastern wall is something less than 15,000 feet.

As evidence in favour of the vegetal origin of these phenomena, Prof. Pickering suggests that although water could not exist at the low pressures obtaining on the lunar surface, yet it might be retained in the soil by capillary attraction and thence feed the vegetation, which at each return of sunlight would develop and thus cause the changes illustrated in the photographs.

CELESTIAL PHOTOGRAPHY AT HIGH ALTITUDES.—An interesting account of the work performed by Prof. Payne and Dr. H. C. Wilson during their sojourn at Midvale (Montana), illustrated by reproductions of two of the photographs